UNIVERSITY OF NATAL

PIETERMARITZBURG
SOUTH AFRICA

WATTLE RESEARCH INSTITUTE

South African Wattle Growers' Union — University of Natal —
Union Department of Forestry

REPORT FOR 1954-1955

(EIGHTH YEAR)

OCTOBER, 1955

UNIVERSITY OF NATAL
PIETERMARITZBURG
SOUTH AFRICA

WATTLE RESEARCH INSTITUTE

South African Wattle Growers' Union — University of Natal —
Union Department of Forestry

REPORT FOR 1954-1955

(EIGHTH YEAR)

OCTOBER, 1955

CONTENTS

	Page
Committee of Control of the Institute	4
List of Staff	5
Foreword	6
Administrative Report	
Buildings and Plantations	7
Administration and Finance	8
Staff	9
Advisory Work, Committees, Conferences, etc.	10
Library	12
Acknowledgements	12
Review of Work in Progress	
(*a*) Silviculture	14
(*b*) Genetics and Plant Breeding	17
(*c*) Chemistry	21
(*d*) Entomology	23
(*e*) Miscellaneous	24
Progress Reports and Papers	
Notes on Insects Observed During the Period 1954–1955. L. L. J. Ossowski	26
Growers' Bulletins	
Planning and Construction of Roads on Wattle Estates. S. P. Sherry and M. A. Stewart	29
Publications	37

COMMITTEE OF CONTROL OF THE INSTITUTE

Appointed by the South African Wattle Growers' Union (3):

S. Clegg, Esq. (*Chairman*).

Major C. J. J. Crowe. (*Appointed November,* 1954).

R. B. Fyfe, Esq.

D. R. Scott, Esq. (*Resigned November,* 1954).

Appointed by the University of Natal (2):

Professor A. J. W. Bayer, D.Sc. (*Vice-Chairman*).

Principal E. G. Malherbe, M.A., Ph.D., LL.D.

Alternate: Professor A. R. Saunders, D.Sc.Agric.

Appointed by the Union Government Department of Forestry (1):

C. E. Lack, Esq., B.Sc.

The Director:

Professor H. Shaw, M.Sc.Tech., Ph.D., F.R.I.C.

Honorary Secretary:

P. G. Leeb-du Toit, Esq., B.Com. (Registrar, University of Natal).

STAFF

(SEPTEMBER, 1955)

DIRECTOR:

H. Shaw, M.Sc.Tech., Ph.D.(Manc.), F.R.I.C.

Silviculture:

S. P. Sherry, M.A.(Oxon.), B.Sc.(South Africa).
K. Roberts, B.Sc.(Wales). (*Appointed January*, 1955).

Technical Assistants:

M. J. Lourens.
I. J. Meiklejohn. (*Resigned September*, 1955).
T. B. Oatley.

Genetics and Plant Breeding:

A. A. Moffett, B.Sc.(Birm.), Ph.D.(Lond.).
Miss K. M. Nixon, M.Sc.(Natal).

Technical Assistant:

G. W. Adams. (*Resigned December*, 1954).
B. L. Arbuthnot. (*Appointed March*, 1955).

Chemistry:

W. S. Martin, Ph.D., D.Sc.(Lond.), A.R.C.S., D.I.C., A.R.I.C.
C. G. Gordon-Gray, B.Sc.Hons.(Natal).

Technical Assistant:

R. A. Jones.

Entomology:

L. L. J. Ossowski, M.F., For.Ing., D.Sc.(Poznan).
C. N. Smithers, M.Sc.(Rhodes), F.R.E.S.

Technical Assistant:

G. B. Wortmann.

Administration:

Miss E. K. Smith.

Non-European:

Six.

Field Experiment Station Overseer (S.A.W.G.U.):

M. A. Stewart.

FOREWORD

Where the subject material of a research institute is a long-term crop like wattle, there must of necessity be a period of some years during which efforts are devoted mainly to laying down and tending experiments, and results are scanty and largely of an interim and tentative nature. This has been the experience of the Institute through the past seven years since its experimental work started. Now, however, it is gradually passing from this phase as completion of the first cycle of some of the earliest trials approaches.

Paradoxically, this is one factor accounting for the smaller number of articles appearing in this Report. It has never been the intention to make the Institute's Reports a medium for final publication of research papers, and in pursuance of this policy, several papers reporting lines of work which have now matured beyond the "progress report" stage have been or are being prepared for formal publication in specialist technical periodicals. Such outside publications will be noted in the Report from time to time and reprints will be available.

An interesting development in the work itself is that some of the long-range experiments are now giving results of immediate practical significance. A notable case is the problem of gummosis in wattle. The Silviculture Section has obtained clear evidence that gummosis is associated with vigour induced by cultural methods, a finding which is already modifying silvicultural advice. Indications from fertilizer experiments also suggest a connection between vigour and gummosis, but the genetical work, on the other hand, suggests that constitutional vigour inherent in the tree does not have this predisposing effect. These results are clearly of outstanding importance in determining the future course of investigations and are of more than passing interest to the practical grower. They also constitute a good example of the value of co-ordinated team work on such involved problems.

A new line of work worthy of note is the study of virus diseases of bagworm recently started by the Entomology Section. Biological control of insect pests offers many attractions and advantages, and the course of this work on artificial infection will be followed with great interest.

H. SHAW, *Director.*

October, 1955.

ADMINISTRATIVE REPORT

BUILDINGS AND PLANTATIONS

Main Building.

After seven years of alternating dust and mud, it has at last been possible to effect a substantial improvement around the main entrance to the building. An area of some 220 square yards immediately in front of the entrance has been levelled, given a four-inch hard-core base, and surfaced with tarmac. Completion of building operations on the neighbouring Agricultural Research Institute has made available a direct, hardened, entrance road from Carbis Road in Scottsville, and the old rough tracks have been abandoned as public approaches. Even during the summer rains, it should now be possible to approach and enter the building without undue hazard or discomfort. The filling in and levelling of a wide terrace running the length of the building has been substantially completed. The cost of this work has been met by a grant from the South African Wattle Growers' Union to the University of Natal Development Foundation.

In the building itself, a long-standing structural defect has, it is hoped, been remedied by the construction of a small section of lean-to roof and the repair and replastering of the adjoining walls. A deep flower-box has been built on each side of the main entrance and the name of the Institute in heavy bronze lettering has been placed over the doorway.

Sweetwaters Genetics Station.

The winding-up of these experiments proceeded more quickly than had been anticipated, and it was possible to abandon the site in March and hand it back to the City Corporation in terms of the lease.

This area of 100 acres, generously made available by the Corporation at a nominal rental, has been used by the Department of Forestry and the Wattle Research Institute in succession for selection and breeding experiments, mainly with black and green wattle.

Field Experiment Station.

Further road-making at Bloemendal has brought the total to over seventeen miles on the 670 acres, leaving less than four miles still to be completed.

A further 40 acres have been laid down to experiments, making just over 200 acres in all, and for the first time, it can be said that more than half of the total area now under wattle was established by the Institute. Several of the older blocks taken over in 1950 in semi-derelict condition have responded surprisingly well to improvement treatment and have provided valuable experience in rehabilitation. There was again a little frost injury to young trees growing in relatively low-lying positions, but the damage was not serious. Bagworm was troublesome in some sections of the farm and both aerial and ground spraying were used to combat it.

For the first time since it was taken over, the farm has shown a working loss. This, however, was clearly foreseen as unavoidable since in smoothing out a very unbalanced series of age classes, the area felled in the past year was far below average. It is anticipated that in the normal course of events, a credit balance will appear next year and will be maintained thereafter.

ADMINISTRATION AND FINANCE

After serving as a representative of the Wattle Growers' Union on the Institute's Committee of Control from its inception in 1946, and before that for several years on the Union's Research Institute Sub-Committee, Mr. D. R. Scott retired in November, 1954, and was replaced by Major C. J. J. Crowe. The Institute and the Committee of Control are greatly indebted to Mr. Scott for his services and support through the difficult early years. He was particularly helpful in a variety of ways during the period of construction of the Institute building and through the phase of negotiations which preceded those operations.

Major Crowe, who farms at Sevenoaks, is a progressive wattle grower who can be expected to make a valuable contribution to the Institute's affairs.

The Committee of Control met three times during the year, Professor A. J. W. Bayer acting as Chairman until Mr. S. Clegg's return from overseas in October. Mr. C. E. Lack was re-nominated as assessor member of the S.A.W.G.U. Field Experiment Station Committee.

Expenditure and Income.

Expenditure during the year was within £30 of the estimate of £21,300 and in addition, a contingency sum of £1,500 set against the appointment of a Plant Physiologist was not used. Total expenditure for the year was £1,075 more than in the previous year, but salary increases alone accounted for over £1,500. On the other hand, there was no capital outlay on motor vehicles during the year. On balance, expenditure on all other items showed very little change from the previous year; administration expenses increased somewhat, while technical expenses decreased. There was a fairly sharp rise in travelling and subsistence costs, due in part to expenses incurred during study leave overseas.

Fees for analytical services were greater by about one half, both government and private samples submitted having increased in number during the year.

The summarized statement of Expenditure and Income for the period 1st September, 1954, to 31st August, 1955, appears below. Detailed Accounts and Balance Sheet are published separately.

RESEARCH INSTITUTE ACCOUNT

1st September, 1954, to 31st August, 1955

Expenditure	£	s.	d.
Research and Administrative Staff Salaries, etc.	17,089	19	1
Travelling and Subsistence	1,324	11	0
Laboratory and Office Equipment and Maintenance	1,346	11	8
Library	252	4	3
Printing and Stationery	298	14	0
General Administration ..	818	3	1
Building Maintenance ..	156	14	11
Building Additions ..	42	10	0
	£21,329	8	0

Income	£	s.	d.
S.A.W.G.U. Grant ..	16,147	3	2
Department of Forestry Grant	5,000	0	0
Analytical Services ..	170	2	0
Sale of Wattle Bark ..	12	2	10
	£21,329	8	0

STAFF

In January, 1955, Mr. K. Roberts joined the staff of the Institute to take up the vacant post of Assistant Silviculturist. Mr. Roberts, a graduate in Forestry of the University College of North Wales, Bangor, came directly from the Forestry Commission of Great Britain, where he had been for some time engaged in forest surveys.

At the beginning of the year, Mr. M. J. Lourens was promoted to a new post of Technical Assistant, Grade II. Mr. G. W. Adams, a Junior Technical Assistant, resigned in December, 1954, and was replaced by Mr. B. L. Arbuthnot.

Two senior members of the staff, Dr. W. S. Martin and Dr. L. L. J. Ossowski, were overseas on long leave during the periods April to September and January to July respectively. During his leave, Dr. Ossowski spent several periods studying special problems. At the British Museum (Natural History), the Institute of Tropical Agriculture, Deventer, and the Rijksmuseum van Natuurlijke Historie, Leiden, he worked on the genus *Acanthopsyche* and the taxonomy of the wattle bagworm; at the Virus Research Unit in the Molteno Institute, Cambridge, virus diseases of insects were studied; and at Rothamsted Experimental Station, methods for the assessment of insect populations were examined. Dr. Ossowski also visited forest areas in Scotland, in the Netherlands, and in Germany where pest control campaigns had been carried out. In view of these activities, Dr. Ossowski's leave was extended by the addition of one month's study leave.

No award of the Wattle Research Institute Scholarship was made for 1955. As this Scholarship has attracted little interest in its present form, the terms and conditions are to be revised for 1956.

Miss P. Crowe, an undergraduate of the University of Cape Town, worked in the Silviculture Section as a vacation assistant during January and February, 1955, carrying out preliminary studies on root development in wattle seedlings and on histological aspects of gummosis in wattle. Several students from the Department of Agriculture, University of Natal, were employed in the Entomology Section to help with the seasonal survey of wattle bagworm.

ADVISORY WORK, COMMITTEES, CONFERENCES, ETC

Advisory.

For the first time since the Institute began to function, the number of advisory letters written (298) showed a small decrease, due almost wholly to the absence of the Entomologist overseas. Nevertheless, the geographical distribution was wider than ever before, no less than eighteen countries or territories being represented. Southern Africa, of course, accounted for much the greater proportion (267), but new ground was broken by enquiries from the Belgian Congo, Cyprus, the Gold Coast, Portugal, and the Territory of New Guinea and Papua. Over two-thirds of the total were accounted for by letters concerning insects and pest control (111) and silviculture and allied subjects (97). There was a considerable increase in the number of requests for Institute publications and there was the usual demand for commercial and general information from banks, insurance companies, industrial manufacturing concerns, free-lance writers, and a variety of individual enquirers.

The number of visits paid by the Silviculturists to growers' plantations where advice was given *in situ* was 65, more than double the number in the previous year. This was due largely to an extended tour, lasting some three weeks, through Northern Natal, the Eastern Transvaal, and Zululand and to a shorter tour including Pondoland and Southern Natal. Despite the absence on leave of the Head of the Section for six months, the Entomologists paid 46 field visits to growers. The Entomology Section also supervised a large part of the 1954 commercial spraying against wattle bagworm and surveyed some 8,000 acres in preparation for the 1955 campaign.

The 115 visitors to the Institute included a party of 27 on the occasion of the meeting in Pietermaritzburg of the Society of Leather Trades' Chemists. Among the visitors were Mr. H. D. Michell, of the United Kingdom High Commissioner's Office, and Mrs. Michell, Dr. C. G. Stephens, Head of the Soil Survey Division of the Australian C.S.I.R.O., Mr. G. V. Jacks, Director of the Commonwealth Bureau of Soil Science, Dr. S. M. Naudé, President of the South African C.S.I.R., Dr. R. A. E. Galley, Director of the Colonial Products Research Laboratory in London, Dr. C. C. Tanner, Director of Imperial Chemical Industries Limited Hawthorndale Research Laboratories, and Dr. H. Vine, Senior Soil Chemist of the Department of Agriculture, Nigeria. Other visitors from outside the Union came from Brazil, Germany, Great Britain, Italian Somaliland, Kenya, Northern and Southern Rhodesia, and Swaziland.

Guided by the experience of the previous year, the Farmers' Field Day at Bloemendal was held this year in two sections, on the 17th and 18th March. This enabled visitors to be conducted over the experiments in smaller groups, with consequent advantage to the individual. Perfect weather conditions prevailed throughout both days, and the lively discussions which took place at every stopping point indicated the keen interest taken by the growers. Not the least valuable aspect of such assemblies is the exchange of information and experience between one grower and another. The attendances on the two days were 79 and 93 respectively. In addition, two groups of Agriculture students and a number of individuals and small parties were conducted over the farm during the year.

Two other Field Days were arranged by Farmers' Associations in collaboration with the Institute. At Kambula, there was an attendance of 45 and at Commondale, 34. Mr. Sherry was present at each and gave an advisory talk, in addition to being available for discussion of individual problems.

During the year, the Institute has been consulted on a variety of topics by the United States Embassy, the Belgian Consulate, the Bundesanstalt für Pflanzenschutz, Vienna, the Forestry Commissions of New South Wales and of Victoria, the F.A.O. Library in Rome, the Inter-African Bureau for Soils, the East African Agriculture and Forestry Research Organisation, the South African Council for Scientific and Industrial Research, the Natal Provincial Roads Department, the National Woolgrowers' Association, the

Union Government Departments of External Affairs, Native Affairs, and Forestry, the Division of Chemical Services, and the Land and Agricultural Bank. Of particular interest among these enquiries were questions on the distribution of the wattle industry in South Africa and the location of its chief manufacturing centres, information and statistics on the production and utilization of wattle timber, legislation concerning silver wattle bark, and public policy in relation to the eradication of silver wattle.

Students of the University of Natal continue to use the Institute freely as a source of specialized information, and members of the teaching staff have been assisted from time to time in research projects. The Geography Department of the University of Cape Town was supplied with information and statistics in connection with the preparation of an economic atlas of South Africa. Requests from schools and training Colleges for descriptive literature and demonstration samples continued unabated.

The Entomology Section again undertook the analysis and interpretation of the growers' answers to the bagworm infestation enquiry sent out by the Wattle Growers' Union and later assisted the Union office in dealing with applications for spraying.

At the request of the Food and Agriculture Organization of U.N.O., the Chemistry Section undertook the analysis of a series of wattle barks from Ceylon. The results provided useful information on the prospects for commercial wattle production in that country. Samples taken by the Government Bark Inspector have been analysed from time to time as a check against the official grading, and several commercial samples of bark and extract, some for certification of export parcels to the Far East, have been analysed at the request of manufacturers. Advice and information have been given in connection with the analytical aspects of factory process control.

The Director and Mr. Sherry collaborated in writing the section on wattle for the forthcoming new edition of the Department of Agriculture's Handbook for Farmers. The Director prepared for the Leather Industries Research Institute's new publication "Wattle Tannin and Mimosa Extract" a chapter on the contribution to research made by the South African Wattle Growers' Union.

The Wattle Industry Exhibit at the 1955 Royal Agricultural Show in Pietermaritzburg took a different and less technical form than in previous years. The Institute, nevertheless, collaborated with the industrial side in assembling an exhibit and preparing literature designed to demonstrate the versatility, the appeal, and the virtues of genuine leather goods.

Committees, etc.

The Director again attended the Annual Meeting of the Leather Industries Research Advisory Council held in Grahamstown on the 15th June, 1955. Two meetings of the Leather Research Institute's Wattle Technical Committee were held in Pietermaritzburg, one in November, 1954, attended by the Director and Dr. Martin, and one in August, 1955, attended by the Director and Mr. Gordon-Gray.

The Director attended all the meetings of the General Committee of the Wattle Growers' Union and, together with Mr. Sherry, served on the Union's Field Experiment Station Committee and Royal Show Exhibit Committee. He was also a member of the Union's Mechanization Committee and, along with Dr. Ossowski, of the Pest Control Sub-Committee.

By invitation of the Department of Native Affairs, Mr. Sherry joined an Inter-departmental Committee formed to investigate the problem of the encroachment of wattle upon arable and pasture land in Native Reserves. He represented the Institute on a sub-committee of the Wattle Growers' Union set up to consider the problem of forest fires, and drafted the memorandum setting out its conclusions and suggesting relevant amendments to the Forest Act. He also prepared, at the request of the Union's General Committee, a draft Optional Model Clause suggested for adoption by Soil Conservation District Committees with reference to the burning of brushwood. Mr. Sherry again served throughout the year on the Committee of the Botanic Society of Natal.

The Director represented the Wattle Growers' Union at a special meeting of the S.A. Lumber Millers' Research Committee called to discuss and make recommendations on the conduct of timber research in South Africa. When, subsequently, the Union decided to institute a Wattle Timber Research Fellowship, Dr. Shaw was nominated by the Council for Scientific and Industrial Research as Chairman of the Fellowship Steering Committee. He later took part in preliminary discussions with the Director and staff of the National Chemical Research Laboratory, Pretoria.

Conferences, Lectures, Meetings, etc.

At the invitation of the C.S.I.R., the Director attended a conference of representatives of special libraries in Natal at which library methods and co-operation between libraries were discussed.

At the request of the Natal Region of the Department of Agriculture, Mr. Sherry represented the Institute at a Conference of Delegates of Soil Conservation Committees held at the Natal Agricultural Research Institute in August. He also addressed meetings of Soil Conservation Committees at Scheepersnek, Paulpietersburg, and Ixopo on wattle management in relation to soil erosion and stream flow.

While on overseas leave, Dr. Martin gave two illustrated lectures to the Soil Science Department in the University of Aberdeen. The first of these was entitled "Wattle Growing in South Africa" and the second "The Development of Agriculture in Uganda." Dr. Martin also visited several research centres where soil studies are in progress. Dr. Ossowski visited a number of research institutes and manufacturing organizations, chiefly to inspect various new types of spraying equipment likely to be suitable for use in wattle. Current forest entomology problems and progress in research were also discussed at several centres.

LIBRARY

With an annual increment of over 60 books and bound volumes of periodicals, stocks overflowed the shelf accommodation in the Library some time ago. Recently, however, suitable additional shelving was obtained and this recurring problem has been solved for the present.

More than double the number of books were added to the Library as compared with the previous year, but somewhat fewer bulletins, reprints, etc., were received. The numbers were 28 and 171 respectively, bringing the totals up to 246 and 1,678. The addition of 40 bound periodicals brought the total up to 238. One new annual report was added to the list of those received.

The Institute is indebted to Dr. G. D. Darby, of The Natal Tanning Extract Company, Ltd., for a copy of his thesis "The Characteristics of South African Wattle Soils".

A number of additions, comprising chiefly the copyright libraries in South Africa and Great Britain and several Colonial Departments of Agriculture, has been made to the permanent mailing list.

ACKNOWLEDGEMENTS

The Institute gratefully acknowledges its indebtedness to the undermentioned for assistance rendered during 1954–55.

To the Natal Agricultural Research Institute and Professor I. J. Smuts for invaluable help in building up and levelling the ground around the main building.

To Mr. P. Dike, of the Public Works Department, for advice on a difficult problem of repairs to the building.

To the Directors of the Commonwealth Institute of Entomology at the British Museum (Natural History), the Institute of Tropical Agriculture, Deventer, the Rijksmuseum van Natuurlijke Historie, Leiden, the Virus Research Unit of the Molteno Institute, Cambridge, and Rothamsted Experimental Station, Harpenden, for facilities freely given to Dr. Ossowski for working with their collections and in their laboratories.

To the Entomologists of the Commonwealth Institute of Entomology and of the British Museum (Natural History) for assistance in identifying entomological material.

To Professor A. A. Rayner, of the Faculty of Agriculture in the University of Natal, for advice on a variety of statistical problems.

To growers who have provided land and facilities for field experiments in their plantations and to those who have reported on the incidence of wattle insects and have sent in specimens for the Institute's insect collection.

To the management and research officers of the Natal Tanning Extract Company, Limited, for copies of internal reports on matters of interest to the Institute.

REVIEW OF WORK IN PROGRESS

(a) SILVICULTURE

1. Thinning Experiments.

(*a*) Experiment No. S.1 at Broadmoor (Wartburg district) received an improvement thinning and was re-measured in March, 1955. The thinning was designed to remove suppressed, diseased, and damaged trees from plots which will be carried to rotations of ten years or more; the average yield of green bark per acre was 0·46 tons. Analysis of the measurements showed that at six years of age, plots at densities of 600 and more trees per acre were significantly suppressed (P=0·05) in relation to plots at densities of 400 and less per acre.

(*b*) Experiment No. S.3 at Bloemendal (Pietermaritzburg district) was measured in January, 1955. At four years of age, plots at densities of 550 and more trees per acre were significantly suppressed (P=0·05) in relation to plots at densities of 400 and less per acre.

(*c*) Experiment No. S.5 on the Clan Syndicate Estate (Albert Falls district) was thinned and measured in November, 1954, and re-measured in July, 1955. At two years and four months, plots at densities in excess of 1,000 trees per acre were significantly suppressed (P=0·05) in relation to plots at densities of 660 and less per acre. By three years of age, however, plots at densities of 750 and more trees per acre had become significantly suppressed (P=0·05) in relation to plots with densities of 600 and less per acre.

(*d*) Experiment No. S.22 was laid out at Bloemendal in March, 1955, to test response to thinnings reducing the stand density from 1,000 to 500 trees per acre at various ages up to five years.

2. Planting Experiments.

(*a*) Experiment No. S.25 was laid out at Bloemendal in January, 1955, to compare survival and growth of seedlings established by the following methods:

Treatment A (Natural regeneration). Hoeing of narrow seed-beds close to the old stumps so as to bury the leaf litter and bring the seed which it contains into contact with the mineral soil.

Treatment B (Line-sowing). Sowing of treated seed in continuous lines in drills made close to the old stumps.

Treatment C (Spot-sowing). Sowing treated seed in holes made at three-foot intervals close to the old stumps.

Treatment D (Strip-burning). Burning of low, continuous piles of litter, raked up close to the old stumps, to stimulate germination of natural seed.

The seedlings in treatments A, B, and D were thinned to an average distance of three feet apart in the row by hand-pulling. The mean stocking per acre and mean seedling height in feet at seven months of age were as follows:

Establishment method	Mean stocking	Mean height
A. Natural regeneration ..	2,228	0·98
B. Line-sowing	2,300	1·42
C. Spot-sowing	1,376	1·02
D. Strip-burning	2,332	1·16
Standard error	71·7	0·096
Significant difference (P=0·05)	221	0·30
Significant difference (P=0·01)	310	0·42

There were no differences in survival rate of seedlings established by natural regeneration, line-sowing, or strip-burning, but all three of these methods gave significantly better rates than spot-sowing.

The height growth of seedlings established by line-sowing was superior to that of naturally regenerated or spot-sown seedlings. There was no significant difference in mean height of seedlings established by natural regeneration, spot-sowing, or strip-burning.

(*b*) Experiment No. S.30 was laid down at Bloemendal in January, 1955, to compare the survival and growth of wattle seedlings raised individually in paper pots, and subsequently transplanted, with that of seedlings established by the normal method of line-sowings *in situ*. Treatments were as follows:

Treatment A. 13-week old seedlings in paper pots.
Treatment B. 9-week old seedlings in paper pots.
Treatment C. 9-week old seedlings in paper pots, fertilized at sowing.
Treatment D. Line-sowings of treated seed *in situ*.

Potted seedlings were planted out three feet apart in six-foot rows and line-sown seedlings were thinned to an average distance of three feet apart in six-foot rows when about six inches high. Superphosphate fertilizer at the rate of 200 lb. per acre was applied in the planting holes in the case of treatments A and B, in the pots at the time of sowing in treatment C, and in a continuous band under the line-sown seed.

About one month after establishment, two heavy storms on successive days caused considerable wash in this experiment and many of the seedlings were covered completely by soil. Treatments B, C, and D, were most affected, since the larger plants in treatment A were rarely completely covered by wash.

Number of surviving seedlings and mean seedling height in feet at seven months of age were as follows:

Type of planting stock	Mean stocking	Mean height
A. 13-week old pot-plants	1,635	1·98
B. 9-week old pot-plants	780	0·92
C. 9-week old pot-plants (with fertilizer)	300	1·25
D. Line-sown seedlings	2,265	0·94
Standard error	85·7	0·135
Significant difference (P=0·05)	297	0·47
Significant difference (P=0·01)	449	0·71

There were marked differences in survival between all treatments, line-sowing giving the best survival rate. The smaller transplants in treatments B and C were adversely affected by wash, and the latter suffered in addition as a result of the high concentration of fertilizer in the relatively small volume of soil in each pot.

As was to be expected, the older transplants in treatment A showed superior height growth to all other types of planting stock at seven months from establishment. It is noteworthy, however, that there was no significant difference in height between the transplants in treatments B and C and the line-sown seedlings, despite a two-month difference in age.

3. Effect of Time of First Hoeing upon Subsequent Weed Density and Early Seedling Growth.

Experiment No. S.26 was laid down at Bloemendal in a block of 7½-year old trees in June, 1954. This block was to be felled in November, 1954, and the hoeing treatments were as follows:

Treatment A. All weed-growth under the standing crop hoed in June, 1954.
Treatment B. All weed-growth under the standing crop hoed in October, 1954.
Treatment C. All weed-growth hoed after extracting the timber in March, 1955.

Drills were made close to the tree rows in all plots and sown with treated seed just prior to felling the standing crop. The resultant seedlings were thinned to an average distance of three feet apart after the final hoeing in March, 1955.

Two months after felling, the percentage weed cover in all plots was determined by means of belt transects and was found to be as follows:

Weeding treatment	Percentage weed-cover
A. Hoeing five months before felling	5·76
B. Hoeing three weeks before felling	7·37
C. No hoeing before felling	12·42
Standard error	1·45
Significant difference (P=0·05)	4·39
Significant difference (P=0·01)	6·10

At two months after felling, there was a significantly greater difference in weed-cover between plots weeded five months before felling and those not hoed before felling than between those hoed three weeks before felling and the unhoed plots. The difference between plots hoed five months and three weeks respectively before felling were, however, not significant.

At four months after felling, when the timber had all been removed, all plots were clean-hoed. This was the second hoeing which plots in the A and B treatments had received and the first hoeing of the C treatment plots.

The total labour requirements for the various weeding operations were as follows:

Treatment A. Two hoeing operations .. .. 8 units per acre.
Treatment B. Two hoeing operations .. .. 9 units per acre.
Treatment C. One hoeing operation .. .. 8 units per acre.

At eight months of age, the mean seedling heights in feet were as follows:

Weeding treatment	Seedling height
A. Hoeing five months before felling	0·94
B. Hoeing three weeks before felling	0·96
C. No hoeing before felling	0·59
Standard error	0·06
Significant difference (P=0·05)	0·19
Significant difference (P=0·01)	0·26

Seedlings were significantly taller (P=0·01) in plots which were hoed before felling than in those which were not. There was no difference in height between seedlings in plots hoed five months and three weeks respectively before felling.

Hoeing during the winter prior to felling and again after the removal of the felled timber resulted in a 59 per cent. increase in mean seedling height at eight months of age as compared with plots hoed only after the removal of the timber, and this increase was achieved without any increase in labour costs. Hoeing immediately before felling had an equally beneficial effect upon seedling growth, but the total hoeing costs were 12½ per cent. higher.

(b) GENETICS AND PLANT BREEDING

1. Green Wattle (*Acacia decurrens*).

Attempts to produce the third inbred generation of green wattle and to test the combining ability of inbred lines were unsuccessful. Twenty-one trees in the S_2 generation were bagged for selfing and crossing, but on the majority of trees, flower buds, although very numerous, were shed before opening, while the few trees on which flowers did open failed to set seed.

2. Interspecific Hybrids.

Measurements of leaf characters in the F_1, F_2, and back-crossed families of green × black wattle (*Acacia mollissima*) hybrids were completed and a preliminary analysis of the data made. The families were also scored at intervals of approximately one month for dates of flowering and the time taken to ripen seed.

The leaf characters measured were petiole length, rachis length, rachilla length, number of pairs of pinnae, number of pinnules, and pinnule length, spacing, and width. All these characters proved to be multifactorial.

Significant differences occurred between F_1 trees from the same parents for all the characters except pinnule length and petiole length. These differences were reflected in the F_2 in a parent-progeny correlation. F_1 trees having a relatively high value for a particular character produced an F_2 also having a relatively high mean value for that character, while conversely, F_1 trees having a low value produced an F_2 with a correspondingly low mean. The back-crosses to black wattle fell between the F_1 and black wattle for most characters, but for some, e.g. number of pairs of pinnae, the back-crossed progeny were scarcely distinguishable from the black parent. Because of the small number of trees obtained, back-crosses to green wattle were not studied.

In the F_2 families, a wide range of recombination of characters occurred, but there was a strong tendency for some of the parental characters to remain associated. Rachilla length and number of pinnules, rachilla length and pinnule length, pinnule length and pinnule spacing, and rachis length and number of pairs of pinnae all showed significant positive correlations, while pinnule length and number of pairs of pinnae were negatively correlated.

Date of flowering also proved to be a multifactorial character. Normally, green wattle flowers in July or early August and black wattle in September or October. In both species, while there is variation between individual trees, the flowering period is well defined within fairly narrow limits; out-of-season flowering is rarely seen.

The F_1 hybrids flowered sporadically practically the whole year round, but there was a fairly well-defined peak period in August–September.

In the F_2 families, there was a wide range of variation in flowering date. A few trees were in full flower by February, and from then until August, an increasing number came into flower. After August, the number decreased, but trees in flower were recorded right up to December. Only in the month of January were no trees recorded as being in full flower. Irregular blossoming over a long period occurred on most trees and it was found extremely difficult to determine the period of maximum flowering.

In the back-crosses to black wattle, flowering date became clearly defined again, the majority having a flowering period coinciding very closely with that of black wattle, and only on one or two trees was occasional sparse out-of-season flowering observed.

The time taken to ripen seed was recorded also, since the two parental species differ markedly for this character. Green wattle produces ripe seed about four months after flowering, whereas black wattle takes some fourteen months to mature its seed.

Like the green wattle parent, the F_1 hybrids all ripened seed in about four months.

Scoring the F_2 for this character was difficult because many trees, due to irregular flowering, carried pods at all stages of development. It was evident that the majority of F_2 trees matured their seeds in four months, but it was difficult to decide with any degree of certainty how many trees took the longer period to ripen their seed.

In the back-crossed families, where the flowering period is clearly defined, more reliable data were obtained. In these families, the two rates of seed maturation were quite distinct, the only difficulty in scoring being caused by premature ripening of a few pods on trees having the longer black wattle period of maturation. Such premature ripening has, however, been observed on black wattle trees; it is frequently associated with disease or injury. The ratio of green wattle type of ripening to that of black wattle was in good agreement with a 3 : 1 expectation in the three families scored. The occurrence of this ratio in a back-cross to the recessive type suggests that the species differ by two major genes of which one or other, if dominant, causes seed to ripen in four months from flowering.

3. Self-pollination and Natural Crossing in Black Wattle.

An account of this work has been accepted for publication elsewhere (Moffett, 1956).

4. Progeny Testing of Parent Trees.

The scoring of the black wattle progeny trials and analysis of the data were continued.

All trials scored for diameter have again shown significant differences between families. There was little or no change in the relative position of families scored in consecutive years and it would seem that after the initial diameter recording, biennial scoring would be sufficient.

From the disease point of view, the data yielded important indications. Highly significant differences were found between families for gummosis, a disease thought to be physiological in origin, which causes a great deal of loss in plantations. On inspection, it appeared that the incidence of gummosis was positively correlated with vigour, but tests showed that the association, if it occurred, did not reach the level of significance.

The progenies also showed highly significant differences in the incidence of black-butt, a disease caused by wood-rotting fungi, mainly *Amauroderma rugosum* and *Schizophyllum commune*. Black-butt frequently follows an attack of gummosis, the lesions caused by the latter permitting entry of the fungal spores. It was not surprising, therefore, to find a fairly strong correlation ($r=0{\cdot}720$, d.f. 19) between the incidence of gummosis and that of black-butt. In spite of this dependence on gummosis, there were indications that families differed in their resistance to black-butt. Families with a high proportion of gummosed trees did not necessarily have a high incidence of black-butt. The data were, therefore, examined further, taking the trees attacked by black-butt as a percentage of the gummosed trees in each family. On these figures, if there is no varietal resistance to black-butt, no significant differences between families should occur, but in point of fact differences significant at the one per cent. level of probability were found.

Further progeny trials were laid down during the year and the number of trees selected for progeny testing was greatly increased.

5. Self- and Open-pollinated Progeny Trials at Sweetwaters.

This trial, comprising the self- and open-pollinated progeny of 17 selected trees of green wattle, was planted in March, 1945, by Dr. Philp and Mr. Sherry. During February, 1955, the trees were felled, final measurements of height and diameter made, and bark yields recorded. Of the original 17 families, the data from four was too meagre to make comparisons; the results from the other 13 families are summarized in Table I.

TABLE I

Green wattle. Self (S)- *and open* (N)-*pollinated progeny trial at Sweetwaters*

Family number	Number of trees		Mean d.b.h. ins.		Mean height ft.		No. of trees stripped		Total bark weight lb.		Bark weight per tree lb.		Number of trees failed to strip		% Trees failed to strip	
	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N
G.17 ..	32	57	5·0	7·0	45·9	62·7	18	53	705	4,088	39·2	77·1	14	4	43·8	7·0
G.18 ..	18	22	5·3	6·9	54·9	65·2	13	22	732	1,395	56·3	63·4	5	0	27·8	0·0
G.20 ..	26	36	4·3	6·6	47·8	61·5	11	35	489	2,389	44·4	68·2	15	1	57·7	2·8
G.21 ..	69	109	5·1	6·8	50·4	62·4	47	104	1,919	7,008	40·8	67·4	22	5	31·9	4·6
G.22 ..	92	100	5·5	6·6	56·3	62·4	82	93	4,042	6,690	49·3	71·9	10	7	10·8	7·0
G.23 ..	60	134	4·5	6·3	46·9	56·4	25	116	786	7,137	31·4	61·8	35	18	58·3	13·4
G.24 ..	22	28	5·7	7·1	52·7	63·4	17	27	1,074	2,197	63·2	81·4	5	1	22·7	3·6
G.25 ..	45	43	5·0	6·6	51·4	62·6	34	40	1,570	2,905	46·2	72·6	11	3	24·4	7·0
G.26 ..	35	37	7·2	6·9	62·0	61·7	34	34	2,792	2,931	82·1	86·2	1	3	2·8	8·1
G.27 ..	83	100	5·2	7·0	52·6	62·6	50	95	2,253	6,671	45·1	70·2	33	3	39·8	3·0
G.28 ..	24	33	5·4	5·9	53·3	53·9	18	25	1,047	1,597	58·2	63·8	6	8	25·0	24·2
G.29 ..	62	90	5·9	5·9	56·7	57·8	54	80	3,817	5,007	61·4	62·6	8	10	12·9	11·1
G.30 ..	6	12	4·5	6·8	48·1	62·7	3	12	144	789	48·0	68·4	3	0	50·0	0·0
Total	574	801	68·6	86·4	679·0	795·3	406	736	20,870	50,804	665·6	915·0	168	63		
Mean	44·2	61·6	5·3	6·6	52·2	61·2	31·2	56·6	1,605	3,908	51·4	69·0	12·9	4·8	29·3	7·9

Measurements made throughout the growing period of the trees had shown that in the majority of families, self-pollination resulted in a marked decrease in vigour as measured by height and diameter. This reduced vigour in selfed, as compared with open-pollinated, plots was reflected in the final recording, not only in a reduced yield of bark per plot (which was partly due to poor stand), but also in a reduced yield of bark per tree and a very much higher percentage of trees which failed to strip. In three families, G.26, G.28, and G.29, there was, however, little difference in height, diameter, or bark yield between selfed and natural progeny. Throughout the growing period, the selfed progeny of G.26 was consistently more vigorous than the other selfed families. Provided no contamination occurred during selfing, G.26 must be regarded as a tree in which little or no reduction in vigour occurs in the progeny following self-pollination. In G.28, the vigour of the natural progeny was well below that of the other open-pollinated families. Philp and Sherry (1946) found that the parent tree, G.28, had the abnormally low calculated cross-pollination of 35 per cent. It is probable, therefore, that a considerable number of the individuals in the open-pollinated progeny of G.28 are in fact the result of self-fertilization.

6. Vegetative Propagation.

Up to 1954, imported sphagnum moss had been used as a rooting medium for air-layers, but as there was some difficulty in obtaining sufficient supplies, a local moss was tried for this purpose. In July, 1954, two air-layers were placed on each of 55 selected trees, sphagnum moss being used for one layer and local moss for the other. Out of the total of 110 layers, 87 (79 per cent.) rooted, 46 of these being in sphagnum moss and 41 in local moss. From these figures, it was concluded that there was little or no difference in rooting between the two types of moss. There was, however, a considerable difference in the time taken for the layers to root on different trees. Sixty-six of the air-layers were cut off and planted by December, 1954, having taken some four to five months to produce roots. Other layers did not produce roots until June, 1955, eleven months after the layer had been put on.

It was decided to try to speed up the rooting process by the use of hormones, and in March, 1955, a small preliminary trial was started. Indolylacetic acid, indolylbutyric acid, and naphthylacetic acid at concentrations of 1,000 p.p.m. in alcoholic solution were painted on to the upper end of the ring-barked area, i.e. the portion from which roots develop, immediately after ring-barking. After two months, four treated layers and one control had rooted. These results seem to indicate that hormones may shorten the time taken to form roots, but further trials are necessary.

Air-layers were put on a further 68 selected trees in May–June, 1955. Local moss was used throughout as a rooting medium and on each tree, one of the two layers was treated with 1,000 p.p.m. indolylacetic acid.

One fact likely to be of considerable importance in the breeding programme has emerged from the vegetative propagation work, namely, that cuttings to a large extent retain the mature characters of the branch from which they were taken. Cuttings flower freely in tins after about a year or eighteen months and with suitable cross-pollination set seed freely. The fact that flowering trees capable of setting seed can be obtained in tins will confer a mobility on the genetical material which should do much to solve the problems of isolation and intercrossing of selected strains.

REFERENCES

Moffett, A. A. (1956). Genetical studies in Acacias. I. Segregation of seedling characters and the degree of natural crossing in black wattle (*Acacia mollissima* Willd.). *Heredity*, **10** (in the Press).

Philp, J. and Sherry, S. P. (1946). The degree of natural crossing in green wattle (*Acacia decurrens* Willd.) and its bearing on wattle breeding. *J.S.Afr.For.Ass.*, **14**, 1–28.

(c) CHEMISTRY

1. Fertilizer Experiments.

No measurements have yet been made this year on the major fertilizer experiments.

(*a*) *Superphosphate.* An experiment designed to find out the optimum dressing of superphosphate and when to apply it was laid down at Bloemendal during January, 1954. Six rates (0, 50, 100, 200, 400, and 800 lb. of superphosphate per acre) were combined with the following four methods of application:

Treatment A. Half under the seed before sowing; remainder between the lines one year later.

Treatment B. Half in bands on either side of the seedling lines at first thinning; remainder between the lines one year later.

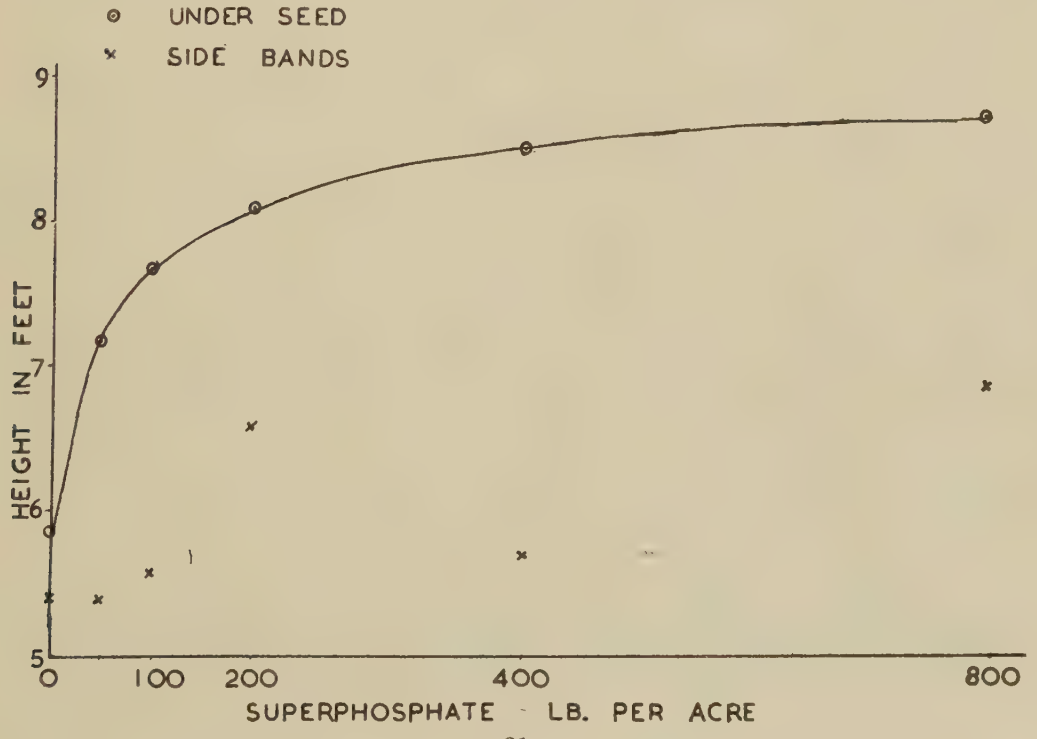
Treatment C. All under the seed before sowing.

Treatment D. All in bands on either side of the seedling lines at first thinning.

After good germination, the seedlings grew well, especially in the plots where the fertilizer had been applied under the seed. The experiment suffered hail damage in the late summer and some frost during the subsequent winter. Fortunately, however, there was ample material for selective thinning and a full stand was obtained on most plots. Measurement of the trees one year after sowing gave the following mean heights in feet:

Treatment	Superphosphate lb./acre						
	0	50	100	200	400	800	Mean
A. ..	6·22	7·09	7·05	7·57	6·29	8·02	7·04
B. ..	5·49	5·54	6·35	5·77	6·83	6·47	6·08
C. ..	5·86	7·16	7·67	8·10	8·55	8·73	7·68
D. ..	5·41	5·40	5·57	6·61	5·70	7·08	5·96
Mean ..	5·74	6·30	6·66	7·01	6·84	7·54	6·69

The results for treatments C and D are expressed graphically below:



It is clear that from the point of view of early growth, it is better to put superphosphate under the seed at the rate of about 200 lb. per acre. This was done at Bloemendal by making a furrow 5″–6″ deep along the seed lines, sprinkling the fertilizer at the bottom of the furrow, covering with an inch or two of soil, and then sowing and covering treated seed. The labour required was between three and four man-days per acre. It remains to be seen whether the early advantage in growth is maintained and if so, whether this induced vigour is beneficial or otherwise in respect of incidence of disease and final yield per acre.

(*b*) *Incidence of Gummosis.* Counts of affected trees on all the fertilizer experiments have again revealed no significant differences due to fertilizer treatment, but again it was particularly noticeable that well-grown trees were affected.

2. Soil Moisture.

Efforts to obtain data on the penetration of rainfall in wattle soils under different silvicultural conditions involve the measurement of soil moisture at different depths, preferably in undisturbed soil. Tests with porous tensiometers have shown them to be unreliable under our conditions. Preliminary work using simple porous pencils dyed with a suitable indicator has shown promise for use on the surface, but even in this restricted field, the variation is such that a large number of replicates is necessary to obtain valid readings.

3. Soil Survey.

A depth survey of a portion of Block 26 at Bloemendal was carried out as a guide for future planting of material by the Genetics Section.

4. Bark Analysis.

(*a*) *Routine analysis.* Approximately 850 samples were analysed during the year in addition to 45 samples submitted by the Government Inspector of Wattle Bark. Agreement between the visual and chemical valuations of percentage tannin in these latter samples was reasonable except in one batch, where the cause of a discrepancy is being investigated.

Co-operative work with the Permanent Technical Committee of the South African Wattle Extract Manufacturers' Association was continued, though on a somewhat reduced scale.

(*b*) *Tree and plot sampling.* The final test of the significance of treatments in field experiments should be based on yield of tannin per acre, and to obtain an accurate estimate of this, some practicable method of sampling trees and plots at the time of felling must be evolved. The most accurate method would be the chopping, mixing, and quartering of all the bark won, but this is laborious when a large number of experimental plots have to be dealt with simultaneously.

It would appear, from the analysis of consecutive six-inch bands of bark from a tree and from the work done by Williams (1928), that the distribution of tannin in wattle trees is very variable. A number of sampling methods, including six-inch collars and weighted pellets, each taken at fixed intervals up the tree or at definite fractions of the tree height, have all been tried. In some cases, these samples have yielded results in good agreement with the total bark analyses, but in others, they have given consistently low figures. Thus unless some simple criterion, e.g. d.b.h. $\times$ height, can be related to tannin distribution, no collar or pellet sampling will be reliable.

5. Seasonal Effects on Extractives in Wattle Bark.

Since August, 1954, five mature trees per fortnight have been felled from a two-acre plot and the total bark removed from each tree for analysis. Due to pressure of other work, the analysis of these samples has not yet been completed. It is intended to continue this experiment over a three-year period.

6. Variation in the Tannin content of Trees.

The sampling of young wattle trees has indicated that the percentage tannin reaches a maximum at an early age. An experiment has been laid down at Bloemendal to obtain information on the variation in tannin content with tree age.

7. Bark Chemistry.

This work was started with a view to ascertaining whether the various species of *Acacia* could be differentiated by their tannin and related components, so that in genetical work, the parentage could be followed from generation to generation.

It therefore seemed necessary to find means of characterizing the components of each species to enable comparisons to be made between them. Effort has been concentrated on the problem of separating and isolating by column chromatography the major components of black wattle tannin which have different RF values on paper chromatograms. Once these separations have been achieved, it should be possible to identify the components and then apply the process to other species.

Identification of the anthocyanidins by the Hillis method has shown that the same anthocyanidins can be present in all the species so far examined; comparison of components fluorescent under ultra-violet light failed to give any definite species pattern.

Column chromatography with different absorbents and different solvents and solvent mixtures is being continued in an effort to effect a segregation of tannin into its constituents.

REFERENCE

Williams, C. O. (1928). South African tanning materials. Part I. The black wattle. *S.Afr.Dep.Agric.Sci.Bull.*, No. 63, pp 20–29.

(d) ENTOMOLOGY

1. Bionomy of Wattle Bagworm.

Data were obtained from 9,657 bagworms for the determination of sex ratio and factor. It was found that the sex ratio was 1 female to 1·2 males and the sex factor 0·45.

2. Effect of Bagworm Attack on Increment.

Except those at Geluk in the Transvaal, all plots laid out to check the effect of bagworm attacks on increment over a ten-year cycle received attention. The former were severely damaged by hail in 1953 and were not infested with bagworms. All sixteen plots at Windy Hill, laid out in 1953 to demonstrate the effect of a bagworm attack in the last years of growth before felling, were measured twice, and eight plots were felled and stripped and the bark weighed and analysed. The assessment of this experiment is in progress.

3. Chemical Control.

(*a*) *Aerial spraying experiment.* The aerial spraying experiment laid out at Windy Hill was not carried out due to external causes.

(*b*) *Commercial aerial spraying campaign, 1954.* During the campaign, studies were carried out and data collected mainly on the influence of the insecticide on bagworms and other wattle insects, especially beneficial ones, and on mammals, birds, and fishes. The technique of spraying and the influence of weather on the dispersal of the insecticide were also studied.

(*c*) *Commercial aerial spraying campaigns, 1952 and 1953.* The study of the effect of these campaigns on wattle plantations and on the cycle of bagworm infestation was continued.

(*d*) *Use of repellents and deodorants.* The outcome of the replicated experiment with an emulsion of oil of buchu was assessed. Buchu appears to have some power of attraction, since the number of fertile females in treated plots was up to 35 per cent. higher than in controls.

4. Biological Control.

Virus disease in bagworms. Polyhedra, containing viruses of a nuclear type which attack bagworms, were isolated and purified. Suspensions containing approximately 3,000,000 polyhedra per mm.^{3} were prepared for use in exploratory experiments during October and November.

5. Study of the Genus *Acanthopsyche*.

The original collection of bagworms of Junod determined by Heylarts, which is at the Rijksmuseum van Natuurlijke Historie at Leiden, and also the collection of bagworms of the British Museum were examined. The results of this study will be published elsewhere.

6. Study of the Life Cycle of Parasites of Bagworms.

An extensive study was made of the life cycle of *Philopsyche abdominalis* Morley and an account is in preparation for publication elsewhere.

7. Parasites of Bagworms.

An ichneumon parasitizing bagworms was identified as *Pimpla trocata* Tosq.

8. Identification of Insects not associated with Wattle.

Beetles damaging eucalypts in the coastal belt of Natal were identified as *Protostrophus salignae* Mshl. (*Curculionidae.*)

9. Records of Insect Outbreaks.

These records at present contain data concerning 39 species on over 170 farms and plantations.

10. Wattle Insect Collection.

The collection of wattle insects now contains 118 species.

(e) MISCELLANEOUS

1. Weed Control by Chemical Means.

Final assessment of the effect of 2:4:5-T on American bramble confirmed the general success of this material. No significant difference was found among various esters and amine salts, but other factors led to rather wide variations between replicates of the same treatment. Results were clearly best in the most vigorous stands, but there was no obvious explanation of some other differences. Since some of the plots were completely free from bramble more than two years after being sprayed, the treatment is potentially a very satisfactory one. It remains to determine the precise conditions necessary for consistent success.

Further experiments have revealed the high resistance of aspen (*Populus tremula*) to selective hormone weed-killers. In the latest trial, heavy spraying of stems during summer has been used, but the results are not yet apparent.

An exploratory experiment was laid down in December, 1954, to determine the possibilities of pre-emergence weed control in wattle re-establishment. Six of the newer weed-control materials were tested by applying them to the bare ground within a few days of planting the wattle seed. Very promising reduction of weed growth resulted in several cases, but none of the materials showed a satisfactory degree of selectivity and, in greater or lesser degree, the stand of wattle seedlings was reduced wherever there was good control of weeds. This work will be continued with other materials and also by inter-row spraying.

In the course of these experiments, an interesting selectivity among the weed species was noticed with several of the preparations.

2. Collaboration with other Organizations.

(*a*) *Studies on the tannins of wattle species.* Samples of fresh wattle bark have again been collected and sent to the Leather Industries Research Institute for constitution and molecular weight studies on the tannins.

(*b*) *Utilization of wattle wood.* A sample of wattle wood for miscroscopic examination of the fibres has been sent to the Institute of Cellulose Chemistry, Darmstadt, Germany, through the South African C.S.I.R. Liaison Officer in London. The results of this investigation have not yet been received.

(*c*) *Design of spraying equipment.* Contact has been maintained and discussions continued with the National Institute of Agricultural Engineering in Great Britain.

PROGRESS REPORTS AND PAPERS

NOTES ON INSECTS OBSERVED DURING THE PERIOD 1954–1955

By L. L. J. Ossowski

An account is given of the insects observed in wattle plantations during 1954–55 and the areas mainly affected are indicated. The effects of an abnormally high summer rainfall are discussed.

The season under review was one of very heavy summer rainfall, with the result that the population of nearly all wattle insects of economic importance decreased during the year. Larvae of some lasiocampids and noctuids, usually seen in abundance, were seldom found, while the life cycle of jassids and capsids was upset or retarded, damage only becoming visible during the early winter instead of late summer as is usual. Bagworms decreased over the greater part of the area except in the drier parts of Natal, where there was an increase in infestation.

I. ORDER. LEPIDOPTERA

Family: *Psychidae*

1. *Wattle Bagworm,* Acanthopsyche junodi, *Heyl.*

During the year under review, the bagworm population decreased in the greater part of the wattle growing area, though in some parts of the Midlands of Natal, it increased. Over 80,000 acres are now infested, and approximately 12,000 acres were completely defoliated.

In the plantations around Port Shepstone, the eruptive stage was reached during the season and the number of bagworms is rapidly decreasing. Around Bizana, however, nearly 1,000 acres were infested and it appears that the infestation there is building up. In some areas near Harding, the bagworm population seems to be on the increase, but the infestation is still in its initial stage. The same is true for the lower-lying plantations around Ixopo and Richmond, but in the higher-lying area of these districts, the infestation is rapidly decreasing. A fairly large wattle estate in the Pinetown Magisterial District has a light infestation over several hundred acres and it appears that at least some 200 acres there may be partially defoliated in 1955–56. Plantations near Howick had very few bagworms, but in the neighbouring district of Lion's River, nearly 2,000 acres were infested and the bagworm population there is on the increase.

The main centres of infestation are in the Midlands of Natal, where some 60,000 acres were infested and nearly 10,000 acres completely defoliated. It was hoped that the exceptionally heavy rains during the summer would cause a very heavy natural mortality, but this happened only in areas with a high annual rainfall. Sampling has shown that mortality in the drier parts of the Midlands, viz. around Dalton, New Hanover, and York, is very low, and larger areas may be defoliated there during the coming season. Around Pietermaritzburg, the infestation is rapidly building up too, and approximately 400 acres may become partially defoliated in 1955. In Zululand, the infestation appears to be light, but shows signs of building up rapidly, especially around Melmoth.

In the southern part of the Vryheid district, some 7,000 acres were infested, but the peak was reached during this season and there are signs of an abatement, though some plantations may be partially defoliated during 1955–56. Wattle plantations in the Transvaal and Swaziland are practically free from bagworms except in the Piet Retief area, where the infestation is slowly building up, but is still in the initial stage.

The heavy rains promoted the development and spread of *Isaria*, particularly around Richmond and Kranskop and in plantations east of Wartburg. Entomophthora (brown) fungus and polyhedral wilt disease were also prevalent, and over six per cent. of the mortality was due to spiders and insect parasites and predators. It was observed that in plantations sprayed from the air, the percentage mortality caused by these enemies of the bagworm was lower than in neighbouring untreated plantations. The number of empty or torn bags was very high during the winter months, especially in younger plantations with dense undergrowth, and there are reasons to believe that rats or mice were responsible.

Over 29,000 bagworms were collected and examined to assess the natural mortality and determine its causes; the following table gives some of the findings according to the months of examination:

Month	Number of			% Mortality due to							Empty bags %	Total mortality %
	plantations	trees	bagworms	isaria	entomophthora	polyhedral wilt	diptera	hymenoptera	spiders	unknown agents		
May	2	11	2,977	9·0	54·2	9·7	0·9	4·4	0·2	0·3	2·3	81·0
June	1	2	425	7·3	37·2	25·9	0·2	4·9	1·2	0·5	5·2	82·4
July	11	150*	6,265	9·9	26·8	7·6	0·05	2·2	0·3	0·1	5·5	52·5
August	27	300*	16,846	12·3	40·3	6·2	0·3	2·5	0·4	0·5	10·8	73·3
September	2	15	2,752	13·6	27·4	6·7	0·07	2·5	0·0	0·0	15·6	65·9

*The number given is approximate. The trees were very young and it was possible to collect all bagworms without felling the tree.

2. *Lictor Bagworm*, Clania moddermanni (*Heyl*).

This species is steadily increasing, especially in young wattle plantations, and was found in larger numbers around Pietermaritzburg and in two plantations north of New Hanover. Damage done was, however, negligible.

Family: *Lasiocampidae*

3. *Grey Wattle Lappet Moth*, Pachypasa truncata *Wlk.*

Very few larvae were observed during the year under review except in one plantation near Ermelo in the Transvaal, where some 50 acres of six-year old wattle were partially defoliated. It was reported from that district that larvae, after having defoliated wattle, invaded *Pinus patula* and partially defoliated younger trees.

Family: *Saturniidae*

4. *Wattle Emperor Moth*, Gynanisa maia (*Klug*).

Approximately 50 acres of four-year old wattles were infested in the Lusikisiki district and some 25 acres partially defoliated. Most probably, the damage would have been more severe if it had not been for flocks of black crows, *Heterocorax capensis capensis*, which invaded the infested plantations, feeding on the larvae.

Family: *Tortricidae*

5. *Wattle Webworm,* Polychrosis incultana *Wlk.*

Larvae of this tortricid were found in plantations near Wartburg, Harburg, and Pietermaritzburg, but the damage done was negligible.

II. ORDER: COLEOPTERA

Family: *Melolonthidae*

6. *Large Wattle Chafer,* Hypopholis sommeri *Burm.*

These beetles were numerous in plantations around Piet Retief, but did little damage. They were also observed in larger numbers in the Ihluku and Richmond wattle areas and around Dalton.

7. *Small Wattle Chafer,* Monochelus calcaratus *Burm.*

Some 80 acres were invaded by this species around Richmond and Greytown, and 20 acres of the latter plantations were partially defoliated.

III. ORDER: HEMIPTERA

Families: *Jassidae* (*Cicadellidae*) and *Capsidae*

8. *Large Green Jassid,* Bythoscopus cedaranus *Naudé,* and

9. *Brown Jassid,* Lygidolon laevigatum *Reut.*

The attack of these sucking insects was not very severe in the year under review. Outbreaks, which usually start during the summer months, were delayed until April and even later, while damage became visible as late as in July and August, instead of in March or April. There are reasons to believe that in some areas, the very heavy rainfall during the summer months upset or retarded the life cycle of these insects.

Approximately 1,000 acres were reported to be attacked and partially defoliated, mainly in the Richmond, Ixopo and, Harding districts.

GROWERS' BULLETINS

PLANNING AND CONSTRUCTION OF ROADS ON WATTLE ESTATES

By S. P. Sherry and M. A. Stewart

The plantations on many wattle estates are served by the most exiguous of road-systems, consisting of the minimum possible length of permanent road supplemented by temporary tracks for exploitation purposes. This is probably due to the fact that roadmaking is generally regarded as a costly and difficult operation requiring heavy and expensive equipment beyond the means of the average grower. Many growers, too, believe that the revenue lost through the occupation of plantable land by roads will not be offset by resultant savings. The purpose of this paper is to show that a properly planned road-system is essential to the economic management of a wattle estate and that it can be developed at a cost well within the means of even the small grower.

Advantages of a Well-planned Road-system.

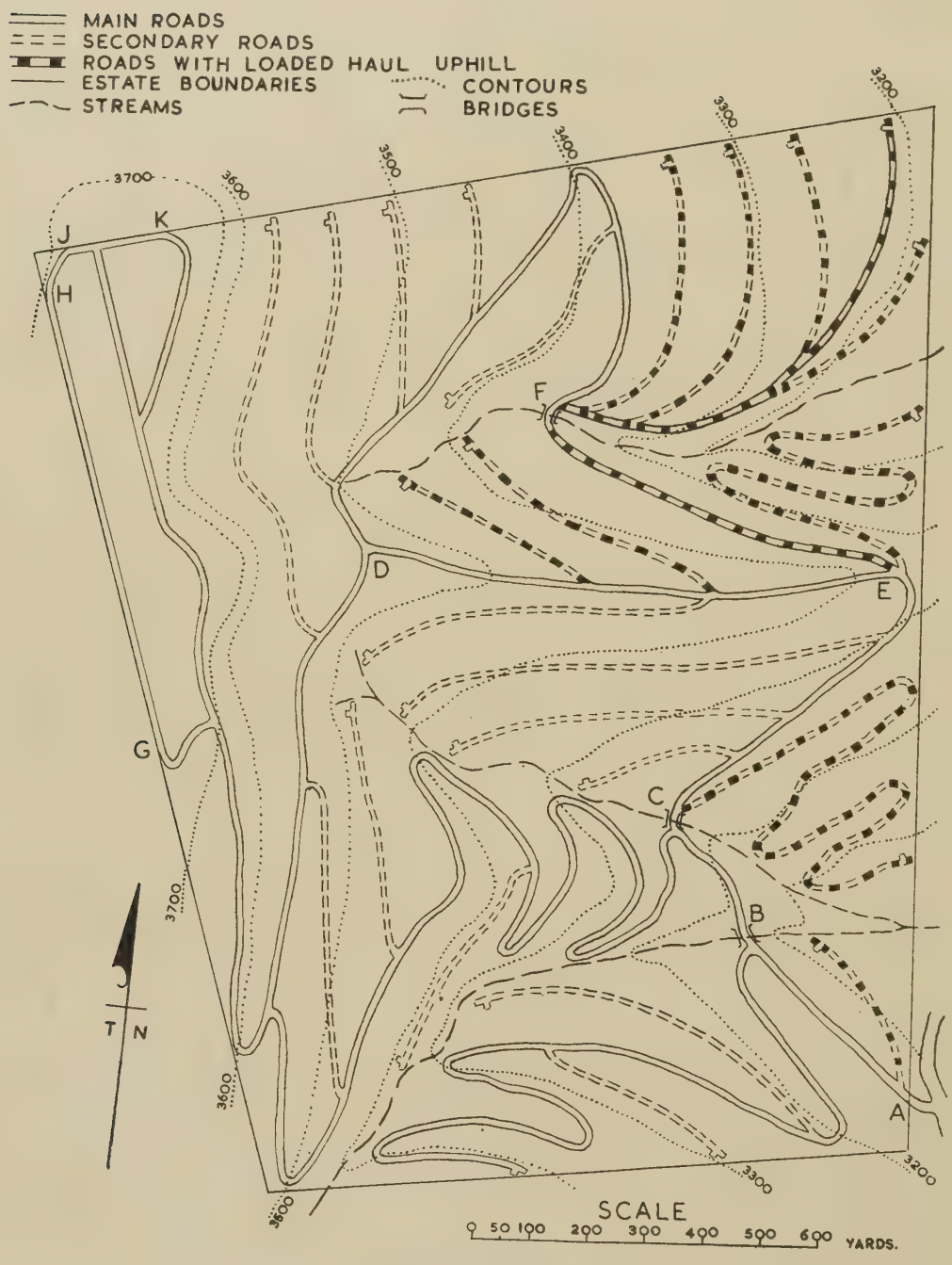
(*a*) *Transport.* Since bark is harvested during the rainy season, a good all-weather road-system is essential if delays in delivering bark to factory are to be avoided. Badly graded roads increase fuel consumption unnecessarily, and rough surfaces place a severe strain on the chassis and suspension of loaded vehicles, thereby contributing to high transport costs.

(*b*) *Plantation Management.* Efficient management of a wattle estate is dependent upon up-to-date information on the rate of growth and state of health of each individual block. Pest-control also is facilitated if infestation centres are detected at an early stage while the area affected is still small. Both these objects can best be achieved by regular inspection of plantations, and this is made possible by the existence of a comprehensive road-system.

(*c*) *Fire Control.* The time-period between detection of an outbreak of fire and the arrival of fire-fighters on the spot is usually the main factor determining the amount of damage done. A good road-system, with roads at fairly close intervals, will shorten the time taken to reach any part of an estate in the event of a fire. The roads themselves form a network of narrow breaks which can be hoed clean comparatively cheaply and used to supplement the main system of fire-breaks. Areas bounded by roads form convenient fire-control and management units which have the additional advantage of relatively small size.

(*d*) *Conservation of Labour.* In view of the increasing difficulty experienced by growers in securing adequate supplies of labour, it is important to have roads as closely spaced as is practicable. It may be possible to husband labour supplies by mechanizing certain plantation operations, but it seems improbable that mechanical stripping of wattle bark, for example, will ever be a practical proposition. Similarly, while it is possible to haul timber out to roadside by means of a winch, bark could not be so handled without suffering considerable deterioration in the process. It is important, therefore, that the stripping labourer should be able to maintain as high a level of output as possible, and any reduction in the distance over which he must carry the bark will be of assistance in this respect.

ROAD PLAN
SUITABLE FOR A TYPICAL WATTLE ESTATE



TEXT-FIG. I.

Planning of a Road-system.

The main requirements in a road-system for a wattle estate are:

(i) Gradients must be as gentle as is practicable without increasing road length unduly.

(ii) The loaded haul should be downhill wherever possible.

(iii) Roads should be sited in such a way that the maximum distance over which bark and timber must be carried does not exceed 50 yards.

Bearing these basic requirements in mind, the main point to be considered in planning a road-system is to ensure that it provides the most efficient possible means of transporting the bark and timber produced on an estate to the nearest railage point or public highway.

The first consideration will be the planning of a main road network, metalled where necessary to provide an all-weather surface, to link up the main plantation sub-divisions. These main roads should converge at a point where they can most easily be linked with a public road. If timber is to be sawn on the estate, the sawmill should be sited below the point where the main estate roads converge, and the estate offices should be situated near this point also. From these main roads, secondary feeder roads serve the various compartments, and since these will be required to carry heavy loads only when the compartments which they serve are exploited, they need not be so wide as the main roads nor do they need to be metalled. They will, however, be regularly used in the course of routine inspections and must not be allowed to become overgrown with weeds or volunteer wattles.

When virgin land is to be afforested, it is advisable to plan and peg out all the roads before planting, but the road-system need not be constructed in its entirety at the outset. It is normally sufficient to complete only the main roads initially, and in course of planting to leave the secondary road traces open. These roads can then be made as opportunity permits after the planting programme is completed. If the road-system on an established estate is replanned or extended, it is usually most convenient to construct the new roads in each block during the autumn and winter preceding the season in which it is exploited. This has the effect of spreading the expenditure on new roads over a period, and of reducing the annual labour requirements for roadmaking to a minimum.

An example of a suitable road-system for a small estate, with topography typical of that found in the wattle growing areas, is illustrated in Text-fig. 1. This imaginary estate is divided by three streams into four main sub-divisions, and there is a small plateau in its north-western corner which is almost completely cut off from the remainder of the area by a steep rock face. A provincial main road passes near the south-eastern corner of the estate, and the system of main roads is aligned so as to traverse each of the five topographical sub-divisions of the property and to converge at a convenient point A near this road.

In this road-system, only 18 per cent. of the total length of road has a gradient steeper than 1 in 20 and the maximum gradient employed is 1 in 15. The roads are aligned in such a way that the loaded haul is mainly downhill. Owing to the nature of the ground, it was not possible to bridge the stream near the northern boundary of the estate at a point lower than F. Consequently, the roads in the north-eastern corner of the property run uphill to this point. The main road from bridge F towards the exit point A also runs uphill as far as E because it was not possible to carry the road around the eastern end of the ridge DE on a down-grade without crossing and re-crossing the estate boundary. Bark and timber from plantations which lie below the main road on the slopes between the bridges at B and C and the southern boundary must also be transported uphill to points A and C respectively. In all, 72 per cent. of this road-system provides a downhill loaded haul.

The distance apart of these roads does not exceed 100 yards in most cases, and on the steeper slopes is often considerably less. In spite of this, the total length of road on the estate is only about 15 miles, occupying an area of about 30 acres, or roughly 6 per cent. of the total area of the estate. When it is remembered that many of the roads occupy part of the area which must necessarily be set aside for fire-breaks, the amount of potentially plantable land lost through constructing such a road-system can hardly be regarded as excessive.

An example of the manner in which plantable land can be saved by siting roads within essential fire-breaks is provided by the roads GH and JK in Text-fig. 1. The topography here permits a straight road to be laid out, and advantage has been taken of this fact to site the road within the 30-foot boundary fire-break.

Laying Out Roads.

The most convenient and inexpensive instrument for laying out roads at predetermined gradients is the Abney level, which can also be used for setting off contours. The instrument is set at the angle equivalent to the gradient which is regarded as the maximum desirable, and the route is pegged on this gradient. A simple sighting-rod for use with the instrument can be made by nailing a wooden cross-piece about an inch wide at right angles to a light pole, so that the centre of the cross-piece is at the same height above ground as the observer's eye when the pole is held upright.

When setting out roads, the sighting-rod is carried forward about 30 yards along the proposed line of the road by an assistant, who moves it up and down the slope until a point on the required gradient is found and marked with a peg. The observer then moves forward to this peg and the rod-carrier goes ahead another 30 yards. It is advisable to peg the route at fairly short intervals so that minor irregularities in the ground may be taken into account and the line of the road altered accordingly.

This preliminary road trace is then re-traversed and the gradient reduced wherever possible, special consideration being given to by-passing obstacles which may complicate construction work. Thus, outcrops of sheet-rock or groups of large boulders should be avoided, and natural terraces should be used where practicable to reduce the amount of excavation in cuttings on steep slopes. If it is found impossible to reach the desired point at the gradient chosen, it may be necessary to accept a steeper gradient for part of the distance or even to seek a new route altogether. In some cases, repeated traverses must be made before a satisfactory route is located, but time spent in this way will usually be more than justified by savings in construction and in subsequent maintenance costs. It may be necessary to adopt a zig-zag route in order to keep a road gradient below a given maximum when there are lateral barriers to progression in one direction. Examples of this will be found in the roads above and below the bridge C in Text-fig. 1.

For maximum utility, earth roads must be adequately drained, and both construction and maintenance are considerably simplified and wear and tear on vehicles reduced if this can be achieved without cross-drains. Roads across sloping ground can be satisfactorily drained by slanting the road surface towards the downhill side at an angle slightly greater than the angle of gradient (Pl. I, fig. 1). The degree of inclination must obviously not be so great as to introduce a risk of vehicles skidding off the road and should not exceed a slope of 1 in 16 unless the surface is metalled. When this degree of tilt is used, cross-drains will not be needed as long as the road gradient is not steeper than 1 in 17. It is sound practice, therefore, in laying out plantation roads to aim at a maximum gradient of 1 in 20. There will inevitably be sections on which this gradient will have to be exceeded, but these should be kept as short as is practicable. Gradients steeper than 1 in 12 should be introduced only where a considerable lengthening of the road would otherwise be necessary, since it is difficult to prevent channelling of the surface on such gradients, even though cross-drains are provided at fairly close intervals. On main plantation roads, which are used constantly for the extraction of bark and timber, only a saving in distance in excess of 30 per cent. will justify the adoption of grades steeper than 1 in 15.

While excessive gradients are undesirable, level stretches of road are equally so, nor should roads be carried through depressions which have no means of lateral drainage, since such sections will quickly become boggy in wet weather. For this reason, all roads should be aligned on a gradient, however slight, when local topography permits, and depressions should be skirted if they cannot be filled in with spoil from adjacent cuttings. When it is impossible to avoid a level section, provision must be made to metal it in order to prevent its becoming boggy in wet weather. Box-cuttings, which are difficult to drain, should also be avoided if possible by lengthening the road slightly, so as to go round rather than through ridges of higher ground.

As an aid in the use of the Abney level for road surveys and construction, a list of angles of slope equivalent to gradients ranging from 1 in 1 to 1 in 100 is presented in Table 1.

TABLE 1

Gradient	Equivalent angle	Gradient	Equivalent angle
1 in 1	45° 0′	1 in 16	3° 35′
1 in 2	26° 34′	1 in 17	3° 22′
1 in 3	18° 26′	1 in 18	3° 11′
1 in 4	14° 2′	1 in 19	3° 1′
1 in 5	11° 18′	1 in 20	2° 52′
1 in 6	9° 28′	1 in 25	2° 17′
1 in 7	8° 8′	1 in 30	1° 54′
1 in 8	7° 7′	1 in 35	1° 38′
1 in 9	6° 20′	1 in 40	1° 26′
1 in 10	5° 42′	1 in 50	1° 9′
1 in 11	5° 12′	1 in 60	0° 57′
1 in 12	4° 46′	1 in 70	0° 49′
1 in 13	4° 24′	1 in 80	0° 43′
1 in 14	4° 5′	1 in 90	0° 38′
1 in 15	3° 48′	1 in 100	0° 34′

Road Construction with Light Equipment.

Roads of the type normally required on a wattle estate can be constructed without undue difficulty, using hand labour assisted by light mechanical equipment. Either wheeled or crawler tractors can be used for this work, but tractors provided with a three-point hitch for the attachment of implements are the most useful on account of their manoeuvrability. The essential implements are a plough, a disc-harrow, and a grader or terracer with an adjustable blade, but a sub-soiler and a tine-cultivator will also be found useful. It must be emphasized that the use of a bulldozer can be justified only on large estates where it is necessary to construct a total length of road in excess of a hundred miles.

On deep soils, roads can be constructed entirely with a tractor and implements, provided the ground is not so sloping that there is a risk of the tractor's overturning. Where, however, soils are underlain by rock at shallow depths or loose boulders occur, hand labour must be employed in conjunction with mechanical equipment. Similarly, across slopes which are too steep for the tractor to traverse, a level footing must be prepared by hand before implements are brought into operation.

Construction work, particularly on earth roads, is best carried out in autumn while the soil is still reasonably moist after the summer rains. The rainy season proper is not suitable for roadmaking because loose soil quickly becomes boggy and difficult to handle; during the winter, on the other hand, the soil is usually too dry to be consolidated properly.

Recommended procedures for constructing roads under various sets of conditions likely to be encountered on wattle estates are set out below:

(*a*) *Roadmaking on gently sloping land.*

Land with an angle of slope of up to 11° falls into this category if wheeled tractors are to be used, but for light crawler tractors, land with an angle of slope up to 20° can be included.

On deep soils, the road trace is ploughed to its full width and to a depth of about six inches if the slope is gentle enough to make the cutting depth one foot or less. On steeper slopes, it is necessary to plough only the upper half to two-thirds of the road trace, since the lower portion will be covered by the spoil from the upper. Before ploughing, all grass and weed growth must be hoed and raked away from that portion of the strip which is to be ploughed, otherwise this loose debris will clog the grader blade and make satisfactory grading impossible. After ploughing, the sods are broken down by means of the disc-harrow, and the grader can then be brought into operation. The grader blade is first set at the smallest possible angle to the direction of travel (usually about 50°) and work is begun from the upper edge of the road trace to push the loose soil downwards and make a level cut. (Pl. I, fig. 2). When the loosened soil has thus been removed from the upper half of the road trace to the lower, it is often possible to continue the cutting to its final depth with the grader blade alone. If the soil is too compact to permit this, the cutting must be deepened by repeating the sequence of ploughing, disc-harrowing, and grading until the desired level is reached. If a corrugated surface is produced in the course of this cutting, it can be smoothed by returning along each line of cut without reversing the angle of the blade, i.e. by scraping towards the upper edge of the road. When the surface has been roughly levelled, the blade should be set at right angles to the direction of travel in order to fill any slight hollows and remove small mounds which show up. Finally, the blade should be set so that it just touches the road surface and two or three traverses made at fair speed in third gear to put the finishing touch to the surface. Where the road surface is to be inclined to the lower side for drainage, grading must be carried out with the blade tilted at the required angle.

On shallow soils underlain by shale at depths of fifteen inches or less, a sub-soiler may be used to break up the shale. The grader may then be employed to move the loosened soil and shale downwards, work being begun near the lower edge of the road since the grader will tend to ride up over the fragments of shale if grading is done from above downwards. Large slabs of shale must, of course, be moved from the path of the grader by hand labour.

When loose boulders occur within the road trace, implements cannot be used until these have been moved aside. Smaller boulders can be levered out with crowbars, but those which are too large and heavy to move by this means, must be split and removed piecemeal. The simplest way to do this is to make a wood fire over each boulder so as to heat it thoroughly, and then to cause rapid contraction and cracking by pouring cold water over it. In winter, if boulders are well heated during the day, the low temperature at night is often sufficient to crack them without the use of water. When breaking up large boulders, a trench extending about eighteen inches below the finished level of the road must be dug around each boulder to ensure that it will be broken off well below the road surface.

If solid dolerite dykes or sills, or reefs of other hard rock are encountered in making a road and cannot be avoided, recourse must be had to blasting in order to remove them.

(*b*) *Roadmaking on steeply sloping land.*

On steep slopes, irrespective of the depth of soil, hand labour must be used to prepare a levelled strip wide enough to give the tractor a footing before mechanical equipment can be brought into operation. Hoes or mattocks are used to make this

cutting, the loosened soil or stone being scraped down the slope as the cut is deepened. Once the cut is wide enough for the tractor, the soil can be moved by the grader as it is loosened by the labourers. If there is good soil depth or if the underlying rock is not too hard, hand labour can be dispensed with after a footing has been completed to the full width required, and the cut can be deepened by alternate use of the plough or subsoiler and grader. Pl. I, fig. 3 illustrates a road in course of construction through hard blue shale on a very steep slope at Bloemendal Field Experiment Station.

(*c*) *Roadmaking through standing plantations.*

When new roads are to be made through existing plantations, the road trace must be stumped before formation work can be begun. This operation can be carried out most easily by hand labour if the lateral roots are cut while the tree is still standing, so that the fall of the tree assists in extracting the stump. The method is illustrated in Pl. I, fig. 4. It will be noted that the lateral roots are severed near their point of attachment to the stem and levered upwards with the point of a mattock, so that an excavation can be made around the root-collar to expose the tap-root. The tree is then felled by severing the tap-root, and the lateral roots are removed by pulling them away from the excavation until they break off below ground.

After stumping is completed and all the large lateral roots have been removed, the road trace may be ploughed. If a tine-cultivator is available, this may be used instead of a disc-harrow to break down the soil, since it will bring the majority of the smaller roots to the surface at the same time. These roots should then be raked off so that they do not clog the grader blade.

On sloping ground, only those stumps which occur on the upper part of the road trace need be removed, since stumps on the lower portion will be covered by spoil from the upper as the cutting is made. Where the slope is so steep that hand labour must be used to prepare a footing for the tractors, trees may be felled in the ordinary way, since the stumps and roots will be removed in the process of excavating the preliminary cutting.

When roads are required for the exploitation of standing plantations, their traces should be stumped during the summer preceding the season in which felling is to take place. The trees removed in stumping can be stripped at this time, and the roads completed during the autumn and early winter, ready for use in the spring.

(*d*) *Provision of turning points.*

Where a road ends at an estate boundary or at a stream or other natural barrier which can be crossed only at considerable expense, it is necessary to make provision for vehicles to turn round. The cheapest method of doing this, particularly on sloping ground, is to construct a reversing bay (Pl. I, figs. 5 and 6). This type of turn involves a minimum of excavation and can be used by all except animal-drawn vehicles. Numerous examples of roads provided with reversing bays will be found in Text-fig. 1.

(*e*) *Construction of cross-drains.*

Provided that drainage on gentle gradients has been secured by means of an outward slope of the road surface, cross-drains will be required only on gradients steeper than 1 in 17. They must be at least twelve feet in width across the bottom, so that they will have adequate capacity without being so deep as to impose undue strain on the springs of laden transport vehicles. Also, of course, the steeper the gradient the closer to one another must cross-drains be made. On sunken roads, care must be taken to continue the line of the drain straight through the bank on the lower side of the road so as to provide the freest possible water movement and obviate blocking, and all such cross-drains must be cleared of vegetation and loose debris before the beginning of each rainy season. In all cases, it is essential to stack brushwood immediately below the discharge points of cross-drains to check the momentum of run-off water and prevent channelling on the slopes below.

(f) Grading of surface drained roads.

On roads which are drained by sloping the surface outwards, loose surface material tends to be washed across rather than down the road. When grading such roads, therefore, preliminary runs should scrape loose material from the lower towards the upper edge, and care must be taken in finishing off that no ridge of such material is left to form a barrier to drainage along the lower edge of the road. Grading should be done when the road surface is only moist after a light fall of rain, since a muddy road surface cannot be graded satisfactorily. Frequent grading of earth roads is unnecessary if laden vehicles can be kept off them for an hour or two after heavy rain to allow the surface to dry out.

Road Construction Costs.

The costs of constructing plantation roads of the types described above will depend primarily on the rates of pay and ration allowances of the labourers employed on this work. Tractor operating costs will also vary according to the make and horse-power of the machine used. Requirements in labour and machinery for road construction, therefore, are best expressed in terms of man days and tractor-and-driver days per mile. The probable range in labour and tractor units per mile required for the various basic operations in plantation road construction are listed below as a general guide in estimating costs. These figures are based on actual work with native labour and a 27 h.p. wheeled tractor in constructing roads of a standard width of fifteen feet. Average costs per mile for the various operations as carried out at Bloemendal Field Experiment Station are given in parentheses.

(i) Hoeing out and raking away grass from full width of road trace, from 40 to 60 labour units, according to the density of grass and weed-growth (£10).

(ii) Stumping over the full width of the road trace, including the stripping of the felled trees, from 45 to 70 labour units, according to the diameter of the trees (£12).

(iii) Preparation of a footing for the tractor on slopes ranging from 12° to 60°,
- (*a*) in soil free of rocks, from 13 to 130 labour units (£12·5),
- (*b*) in partially weathered, friable shale, from 20 to 200 labour units (£26),
- (*c*) in hard, blue shale, from 35 to 350 labour units (£60).

(iv) Quarrying, loading and spreading shale to a depth of four inches,
- (*a*) partially weathered shale, 240 labour units (£48),
- (*b*) hard, blue shale, 330 labour units (£66).

(v) Ploughing, disc-harrowing, and grading in grassland on deep soil, from 2 to 3 tractor units (£2·5).

(vi) Ploughing, tine-cultivating, and grading in stumped land on deep soil, from 2½ to 4 tractor units and 3 to 4 labour units (£3·5)

(vii) Sub-soiling and grading on shallow soil over shale on slopes ranging from 5° to 11°, from 20 to 50 tractor units and 20 to 50 labour units (£29).

ACKNOWLEDGEMENT.

The thanks of the authors are due to Mr. J. Hunt Holley, Sen., for much useful advice drawn from his long personal experience in the construction of estate roads.

Fig. 1. Road with surface inclined to the downhill side for drainage.

Fig. 2. Grader blade set for making a cutting on gently sloping land.

Fig. 3. Deep cutting under construction with hand labour.

Fig. 4. First stage of stumping by hand.

Fig. 5. Vehicle entering a reversing bay.

Fig. 6. Vehicle after completing the turn.

PUBLICATIONS, 1954–55

Anon. .. .. .. "The Wattle Research Institute Report for 1953–1954 (Seventh Year)." *The Wattle Research Institute,* October, 1954.

Ossowski, L. L. J. "Notes on Insects Observed during the Period 1953–1954." *Rep. Wattle Res. Inst. for 1953–1954* (1954), 44.

Ossowski, L. L. J. "An Aerial Spraying Experiment Against the Wattle Bagworm (*Acanthopsyche junodi,* Heyl.)." *Rep. Wattle Inst. Res. for 1953-1954* (1954), 49.

Ossowski, L. L. J. "A Note on the Use of Insecticidal Fogs Against the Powder-Post Beetle, *Lyctus brunneus* (Steph.)." *Rep. Wattle Res. Inst. for 1953–1954* (1954), 56.

Shaw, H. .. .. "The Control of Bramble by Chemical Weed-killers." *Rep. Wattle Res. Inst. for 1953–1954* (1954), 54.

Sherry S. P. .. "The Effect of Different Methods of Brushwood Disposal upon Site Conditions in Wattle Plantations. II. A study of Run-off and Erosion During the First Two Years after Clear-felling and Regeneration." *Rep. Wattle Res. Inst. for 1953–1954* (1954), 27.

Copies of the above publications may be obtained on application to the Institute.

Printed by THE NATAL WITNESS (PTY) LTD. *at Pietermaritzburg,*